QUALCOMM Incorporated

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March 8, 2018

***Ex Parte* Notice**

Ms. Marlene Dortch
Secretary
Federal Communications Commission
445 12th Street, SW
Washington, DC 20554

Re: Promoting Investment in the 3550-3700 MHz Band – GN Docket No. 17-258

Dear Ms. Dortch:

Qualcomm is resubmitting this *ex parte* notification because the earlier filing inadvertently omitted the attachment.

On March 6, 2018, Qualcomm had a telephone meeting with representatives from the Commission's Office of Engineering and Technology to discuss the FCC's proposed revisions to the emissions limits for the 3.5 GHz band in the above docket. Qualcomm was represented on the call by Gene Fong, Marco Papaleo, Pushp Trikha, and the undersigned. The FCC was represented by Julius Knapp, Robert Pavlak, and Walter Johnston.

Qualcomm presented the simulation results in the attached deck, which show that implementation of the Qualcomm emissions proposal cures the problem in the current FCC rules that require significant automatic power reduction for user equipment ("UE") operating with a channel bandwidth wider than 10 MHz, while the so-called graduated emissions proposal provides less relief. We discussed the tradeoffs involved in revising the emissions mask — the need to fully protect operations in adjacent bands, the need to avoid imposing an undue power reduction penalty on UEs operating with a channel bandwidth wider than 10 MHz, and the need to avoid allowing any undue noise within the 3.5 GHz band. Qualcomm noted that its emissions proposal does not lessen the relative value of any of the 3.5 GHz channels.

Enabling both 4G and 5G operations in the 3.5 GHz band using channel bandwidths greater than 10 MHz, without requiring any undue power reduction for UEs, without unduly impacting operations on adjacent channels within the 3.5 GHz band, and without causing any harmful impact on operations in adjacent bands, is key to delivering the best possible mobile broadband service for consumers while maintaining the value of all the channels in the band. Qualcomm explained that balancing the multiple factors in play leads to the conclusion that the Commission should adopt Qualcomm's proposal because it will enable improved wireless coverage, protect the utility of the band for both 4G and 5G, and avoid interference to other users. Qualcomm's proposal is especially important because 3.5 GHz is a key spectrum band around the world for 5G, which will use bandwidths much wider than 10 MHz.

Qualcomm noted that it provided this summary of the attached simulation results in its Comments and Reply Comments in this docket: The graduated emissions proposal requires a transmit power reduction that exceeds the power reduction required by the Qualcomm proposal of as much as 2.5 dB for 20 MHz channels, 1.3 dB for 30 MHz channels, and 0.8 dB for 40 MHz channels.

Finally, Qualcomm explained that its emissions mask proposal would maintain the -40 dBm/MHz additional protection level in FCC Rule Section 96.41(e)(2), so there would not be any increased negative impact to the incumbent operations in the spectrum bands below and above the 3.5 GHz band.

Respectfully submitted,

Dean R. Brenner
Senior Vice President, Spectrum Strategy &
Technology Policy

John W. Kuzin
Vice President and Regulatory Counsel

Att.

cc: Julius Knapp
Walter Johnston
Robert Pavlak

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Qualcomm

Evaluation of power backoff required to meet CBRS emission proposals

March 6, 2018

Emission mask proposals

Three emission mask proposals were evaluated. We assessed the UE total power backoff required to comply with each emission mask proposal.

Option 1. Original mask in *3.5 GHz First Report and Order*

0 to 10 MHz: -13 dBm/MHz
Beyond 10 MHz out to 3530 MHz or 3720 MHz: -25 dBm/MHz
Below 3530 MHz or above 3720 MHz: -40 dBm/MHz

Option 2. Scaled to channel bandwidth ("Qualcomm proposal")

0 to B MHz: -13 dBm/MHz (B=channel bandwidth, for B>10 MHz)
Beyond B MHz out to 3530 MHz or 3720 MHz: -25 dBm/MHz
Below 3530 MHz or above 3720 MHz: -40 dBm/MHz

Option 3. Graduated mask ("alternative proposal")

0 to $B/2$ MHz: -13 dBm/MHz ($B/2$ = half channel bandwidth, for B>20 MHz)
$B/2$ to B MHz: -20 dBm/MHz
Beyond B MHz out to 3530 MHz or 3720 MHz: -25 dBm/MHz
Below 3530 MHz or above 3720 MHz: -40 dBm/MHz

LTE waveforms simulated

- QPSK modulation
- Power class 3, 23 dBm total
- Single carrier 20 MHz (contiguous and non-contiguous allocations)
- UL intra-band contiguous CA (up to 2 CC’s adjacent to one another)

  10+20, 20+10, 20+20 MHz
- Inner channels and edge channels

Summary

Power backoff required to meet emissions

Inner channels

	Original mask	Qualcomm proposal	Graduated mask
Single carrier, 20 MHz (low resource allocation)	3.8	0	1.8
Single carrier, 20 MHz (high resource allocation)	2.2	1	1
Single carrier, 20 MHz (non-contiguous resource allocation, low resource allocation)	11	6	8.5
UL CA contiguous allocation, 10+20 MHz (Low resource allocation)	3.8	0.5	1.8
UL CA contiguous allocation, 10+20 MHz (High resource allocation)	3.8	2.2	2.2
UL CA contiguous allocation, 20+10 MHz (Low resource allocation)	3.8	0.5	1.8
UL CA contiguous allocation, 20+10 MHz (High resource allocation)	3.8	2.2	2.2
UL CA contiguous allocation, 20+20 MHz (Low resource allocation)	3.8	1	1.8
UL CA contiguous allocation, 20+20 MHz (High resource allocation)	3.8	2.2	2.2

Edge channels

	Original mask	Qualcomm proposal	Graduated mask
Single carrier, 20 MHz (High resource allocation)	4.2	4.2	4.2
Single carrier, 20 MHz, non-contiguous allocation	14.5	14.5	14.5
UL CA contiguous allocation, 10+20 MHz	12	12	12
UL CA contiguous allocation, 20+10 MHz	12	12	12
UL CA contiguous allocation, 20+20 MHz	12	12	12

3GPP spec for original mask

Table 6.2.4-22: A-MPR for "NS_27"

Parameters				
Channel bandwidth [MHz]	**RB_{start}**	**RB_{end}**	**L_{CRB}**	**A-MPR**
15	0 – 6		≤ 15	≤ 4 dB
		68 – 74		
	≥ 0		≥ 60	≤ 2 dB
20	0 – 12		≤ 20	≤ 4 dB
		87 – 99		
	13 – 15		≤ 3	≤ 1 dB
		84 – 86		
	≥ 0		≥ 60	≤ 3 dB

Table 6.2.3-1: Maximum Power Reduction (MPR) for Power Class 1, 2 and 3

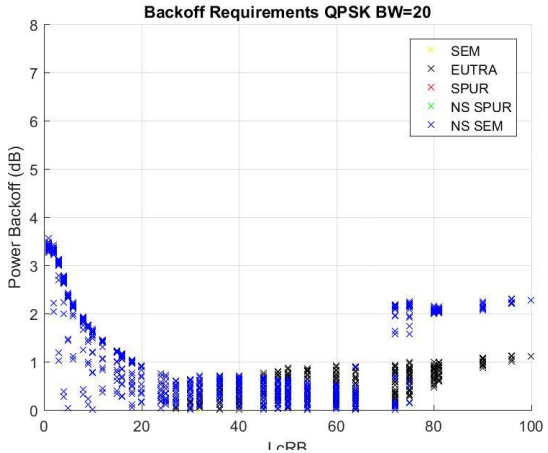
Modulation	**Channel bandwidth / Transmission bandwidth (N_{RB})**						**MPR (dB)**
	1.4 MHz	**3.0 MHz**	**5 MHz**	**10 MHz**	**15 MHz**	**20 MHz**	
QPSK	> 5	> 4	> 8	> 12	> 16	> 18	≤ 1
16 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	≤ 1
16 QAM	> 5	> 4	> 8	> 12	> 16	> 18	≤ 2
64 QAM	≤ 5	≤ 4	≤ 8	≤ 12	≤ 16	≤ 18	≤ 2
64 QAM	> 5	> 4	> 8	> 12	> 16	> 18	≤ 3
256 QAM	≥ 1						≤ 5

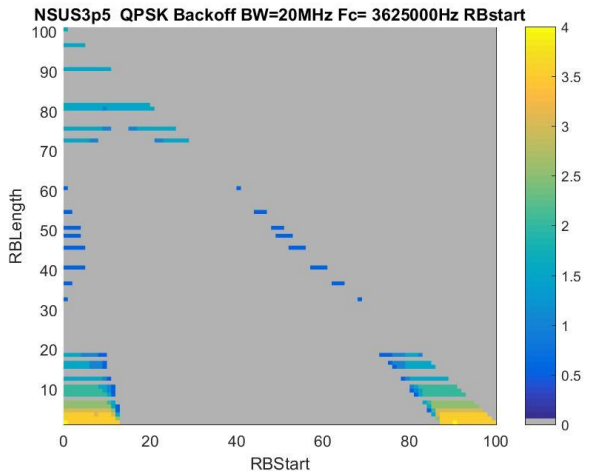
- Only 15 and 20 MHz bandwidths require A-MPR
- Total backoff = MPR + A-MPR
- UL CA has not been specified
- The requirements apply regardless of channel location, so no distinction between edge channels and inner channels

Simulations for original mask

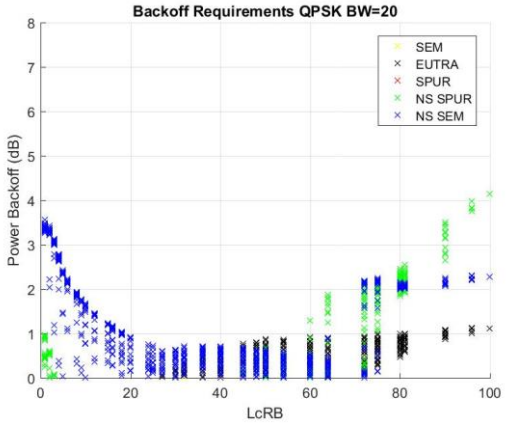
20 MHz single carrier

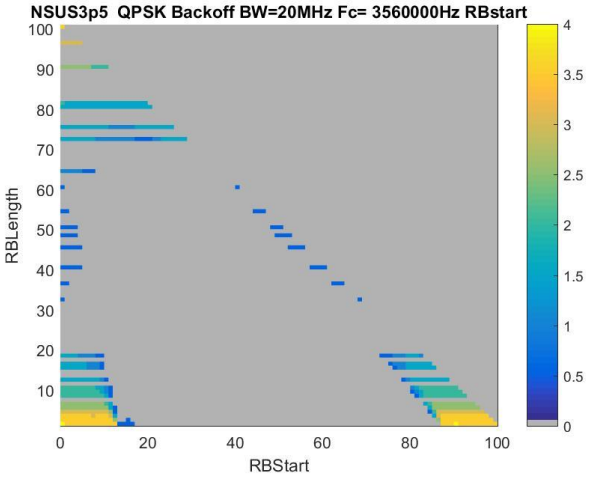
Inner channel





Edge channel





- Simulation results are largely consistent with 3GPP specifications
- The 3GPP spec captures backoff required for the edge channel and applies it generally throughout the band

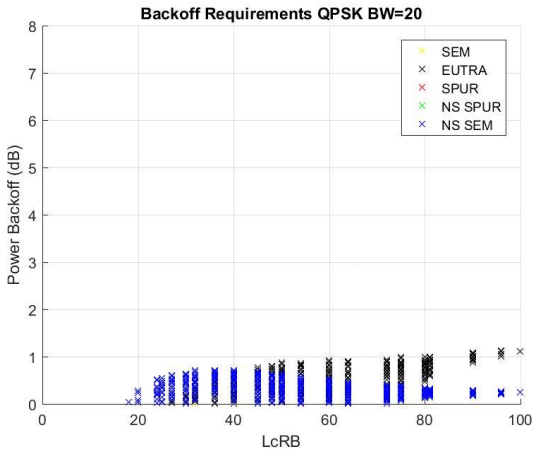
Maximum backoff for QPSK is 4 dB

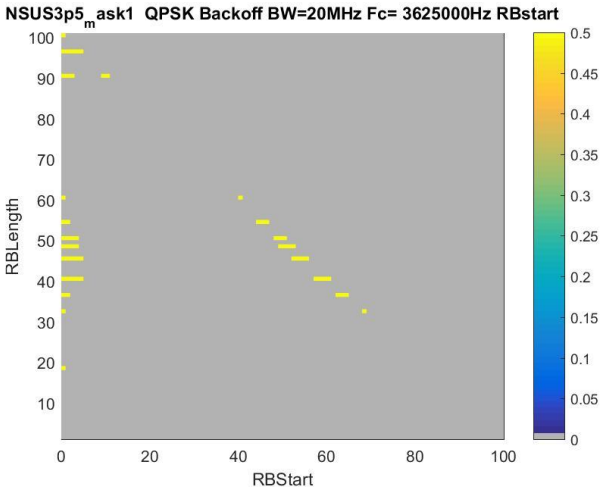
This is codified as 1 dB MPR + 3 dB A-MPR in 3GPP specifications

Simulations for Qualcomm-proposed mask

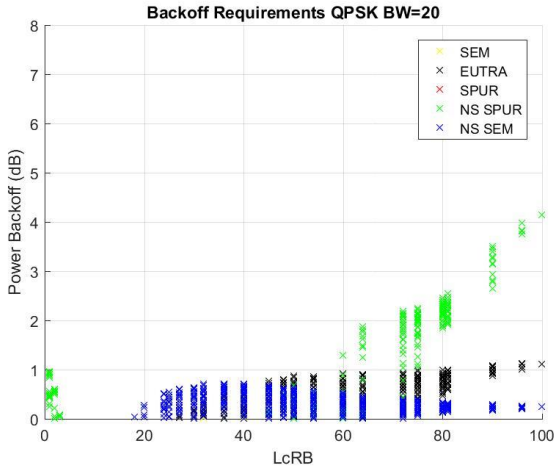
20 MHz single carrier

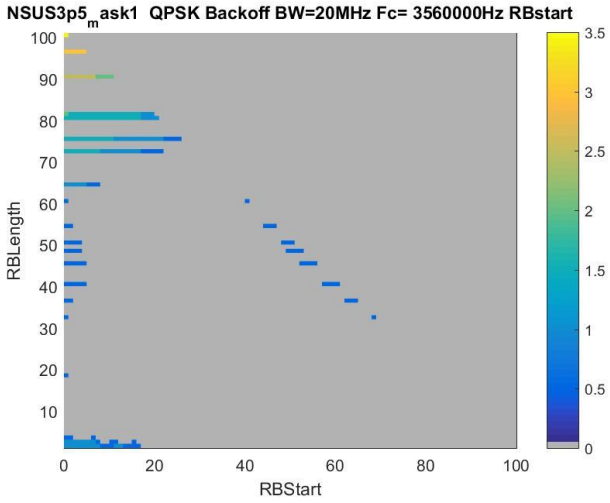
Inner channel





Edge channel





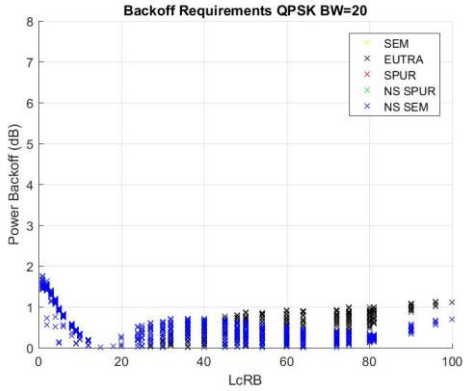
- Power backoff reduced for inner channels, reduced from 4 dB to 1.2 dB
- Edge channels are still dominated by -40 dBm/MHz requirement.
  - No reduction in max power backoff realized in edge channels for large allocations.
  - There is up to 3 dB reduction in max power backoff for small allocations.

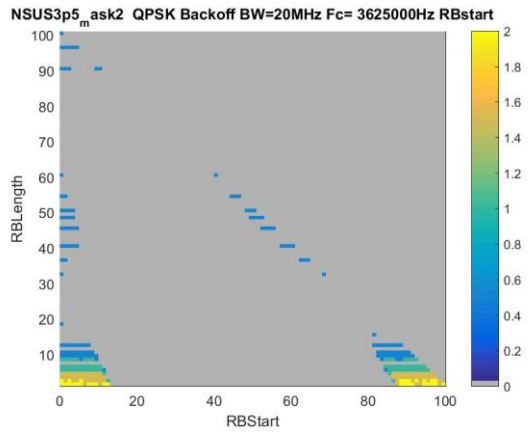
Maximum backoff for QPSK is 0.5 dB, reduced by up to 3.5 dB compared to original mask (inner channels)

Simulations for graduated mask

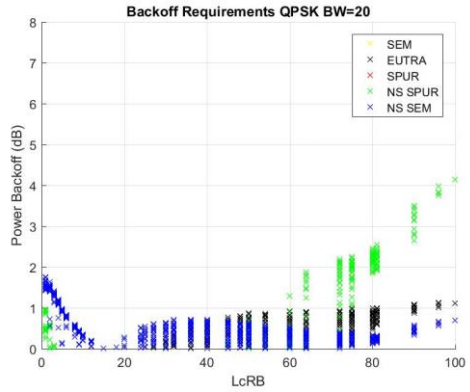
20 MHz single carrier

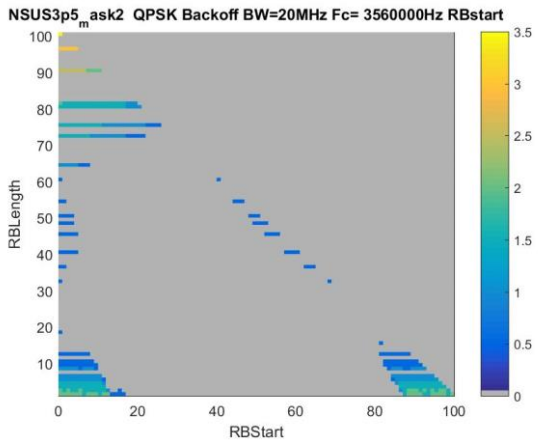
Inner channel





Edge channel



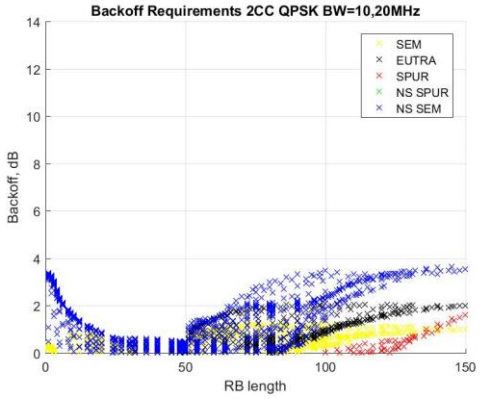


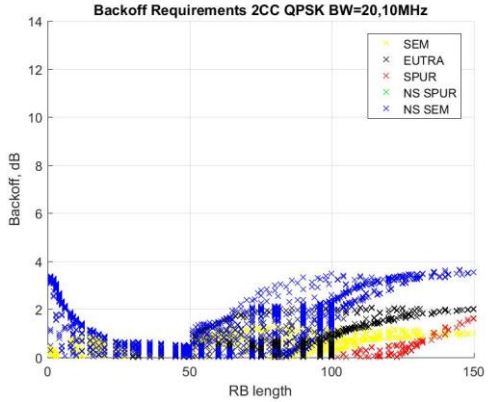
- Power backoff for inner channels reduced from 3.8 dB to 1.8 dB
- Edge channels still dominated by -40 dBm/MHz requirement.
  - No reduction in max power backoff realized in edge channels for large allocations.
  - There is up to 2 dB reduction in max power backoff for small allocations.
- Maximum backoff for QPSK is 2 dB, reduced by up to 2 dB compared to original mask (inner channels)

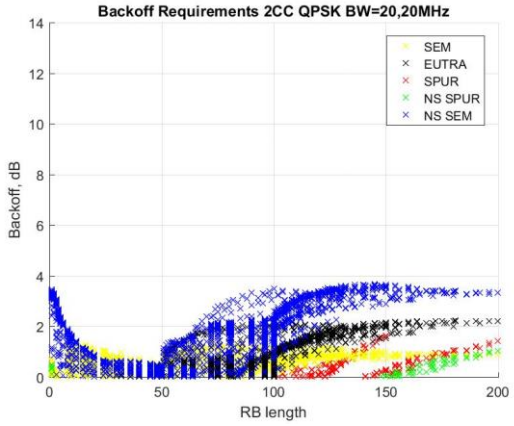
UL CA contiguous allocation, original mask

10+20, 20+10, 20+20 MHz

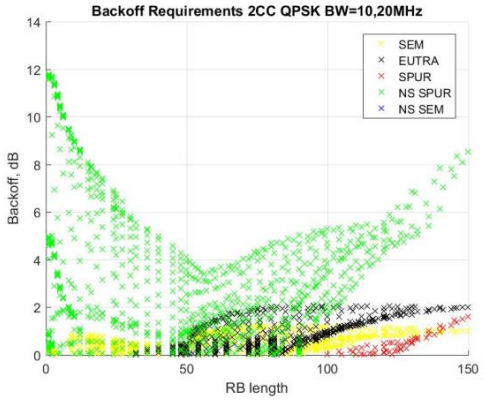
Inner channel

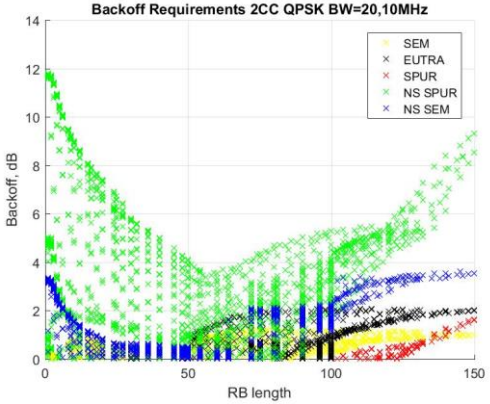


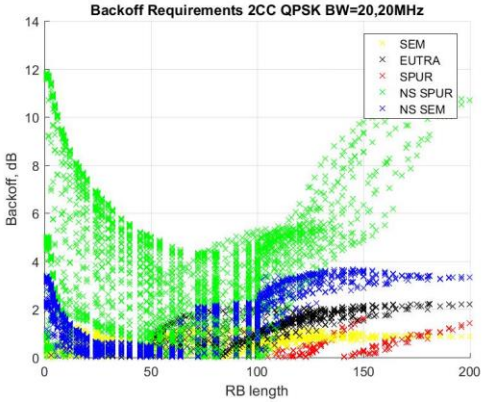




Edge channel





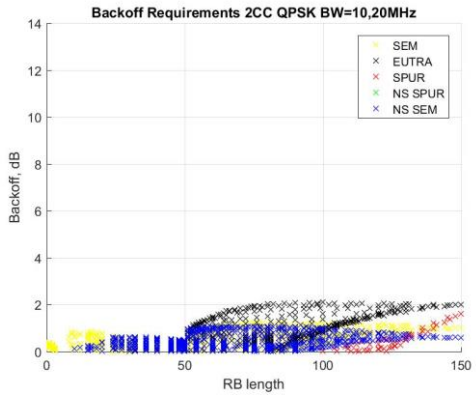


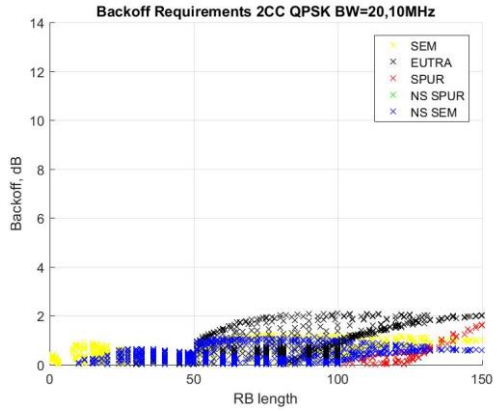
Inner channels, max backoff = 3.8 dB
Edge channels, max backoff = 12 dB

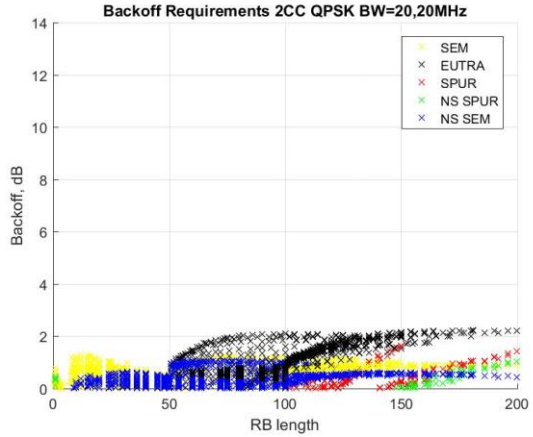
UL CA contiguous allocation, Qualcomm proposed mask

10+20, 20+10, 20+20 MHz

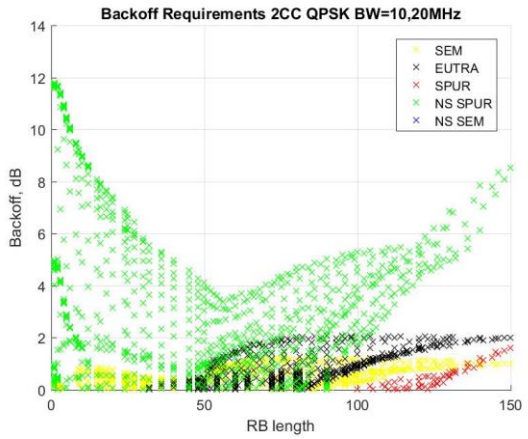
Inner channel

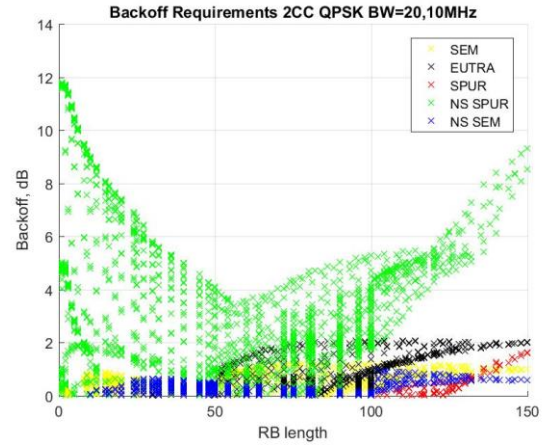


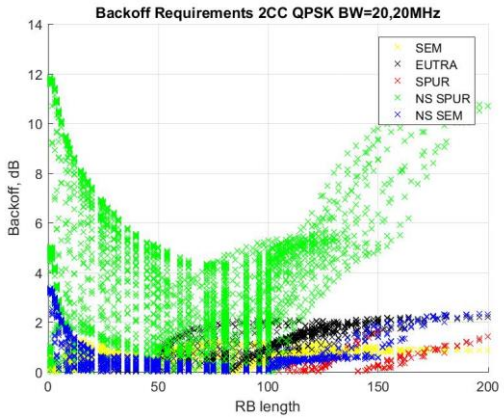




Edge channel







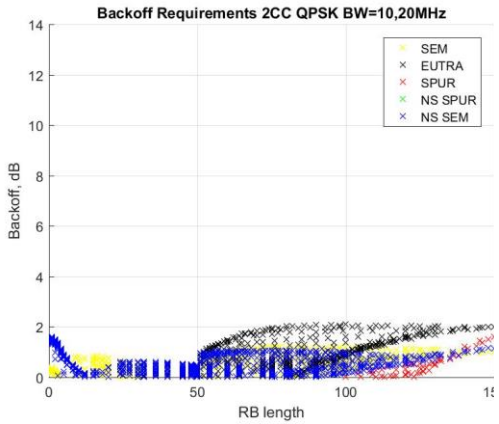
Inner channels benefit in the 20+10 case where the max backoff reduced from 3.8 dB to 2.2 dB

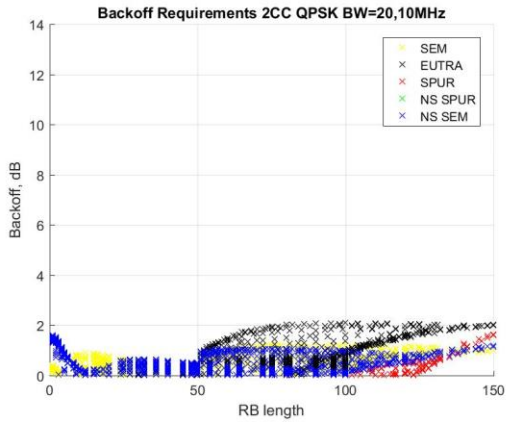
Edge channels: no significant benefit

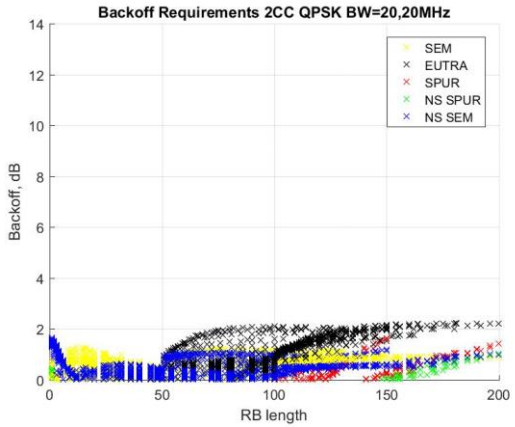
UL CA contiguous allocation, graduated mask

10+20, 20+10, 20+20 MHz

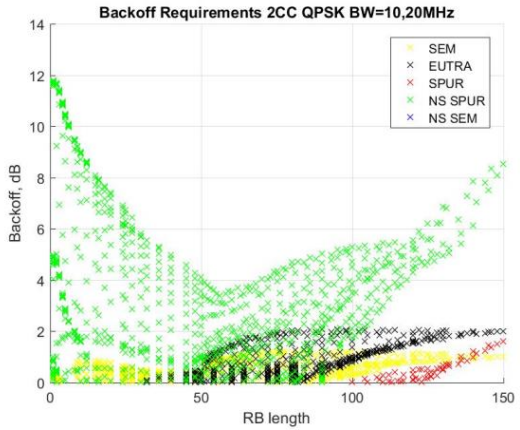
Inner channel

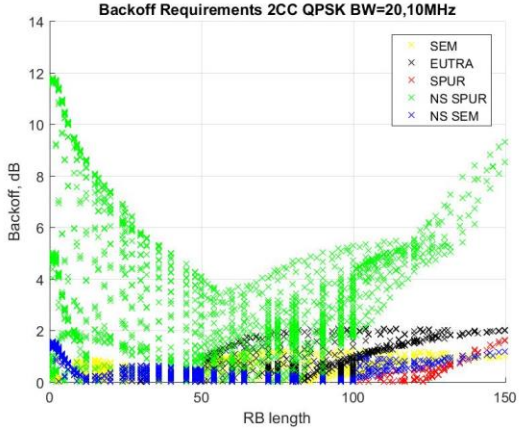


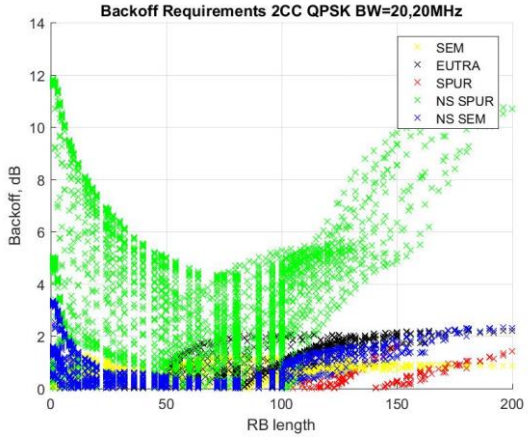




Edge channel





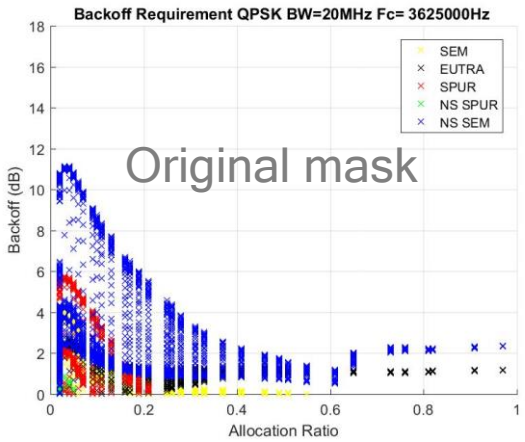


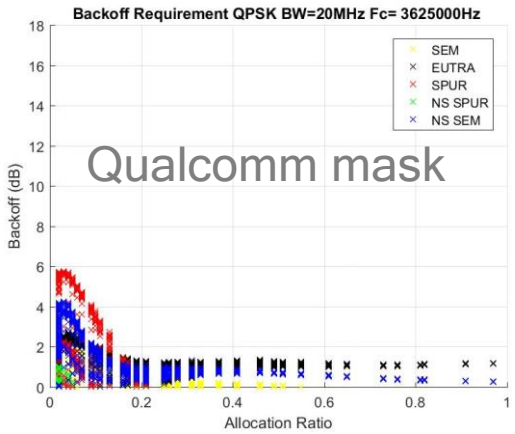
Inner channels benefit in the 20+10 case where the max backoff is reduced from 3.8 dB to 2.2 dB

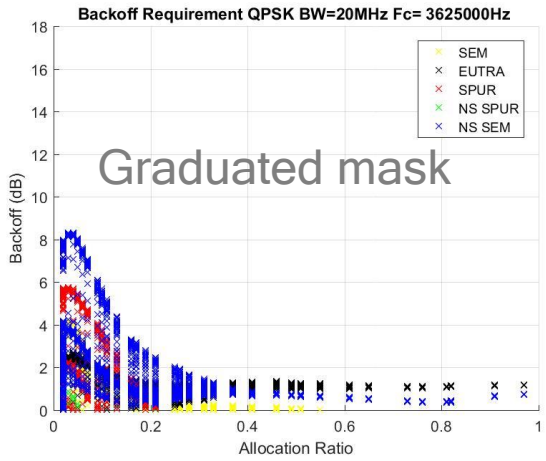
Edge channels: no significant benefit

Single carrier non-contiguous allocations

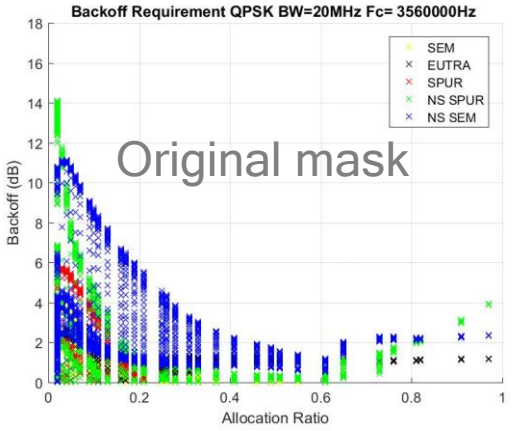
20 MHz carrier

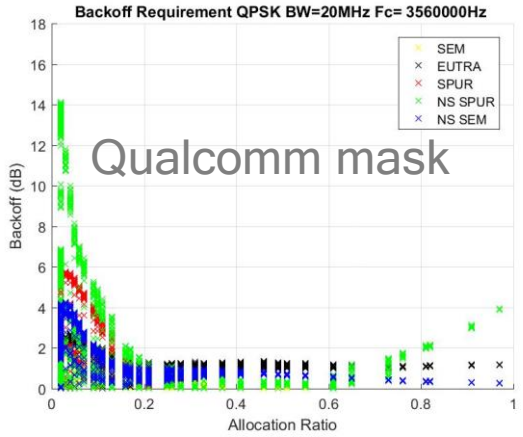


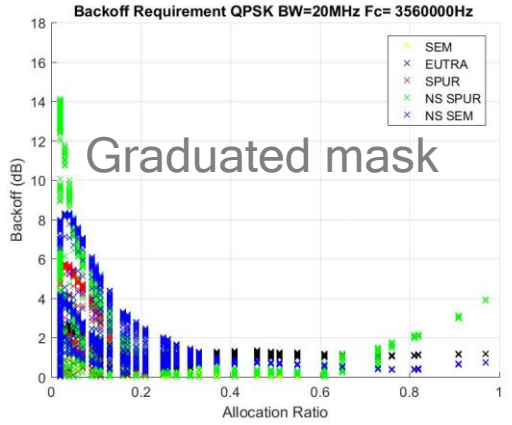




Inner channel







Edge channel